Autonomous Robot Navigation

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Abstract:

This paper reports on developing an intelligent navigable Robot using GPS, GSM and Digital compass. The robot moves according to the GPS coordinates and the destination is given by user in the form of SMS message. The robot also uses ultrasonic sensor to detect obstacles in its way and when it finds any obstacles it stops and sends the location to the user in the form of SMS messages.

Keywords: PIC18F452 Microcontroller, GSM, GPS, Digital compass, Ultrasonic sensor.

1. INTRODUCTION

The modern automobile is an important innovation which casts a direct impact on the everyday lives of humans. It has allowed man to travel long distances in a relatively short period of time and has undergone developments from time to time to enhance its capabilities and improve its

performance in terms of speed, maneuverability, aesthetic look, design,

comfort and features. The development of autonomous vehicles is a

fast growing field within the modern automobile sector. Working prototypes of autonomous vehicles have been introduced by various research organizations and companies, which allow vehicle to drive to a destination without human input. Such vehicles have numerous applications, ranging from commercial use on roads, scientific research and monitoring of environment which is unsafe or unreachable for humans, and for surveillance and espionage purposes. It is essential that such vehicles navigate to the precise user-defined destination while taking shortest path. It is also imperative for any autonomous vehicle to effectively avoid collision and prevent accidents so that it performs its functions and drives to the destination.

The potential application areas of the autonomous navigation of mobile robots include automatic driving, guidance for the blind and disabled, exploration of Dangerous regions, collecting geographical information in unknown terrains like unmanned exploration of a new planetary surface, etc.

2. LITERATURE SURVEY:

Technologies and resources

2.1 MOBILE ROBOT NAVIGATION

Successful mobile robot navigation requires control algorithms that are capable of navigating in complex unstructured environments. These control algorithms must have capability to navigate in cluttered environment. Fuzzy kohonen clustering network (FKCN) is adopted for mobile robot navigation. This logic provides navigation engine using simple fuzzy logic controller and behavior-based robotics. While controlling the robot in different kinds of uncertainties, novel concepts of direction weights are used. A preference-based behavior control system for robot navigation in cluttered environment has been presented. Multi-valued concept is used to develop control system. In preference-based behavior control without neglecting any behavior, the robot is able to navigate towards goal without distracting by the presence of cluttered environment. The path planning for mobile robot navigation in ware house environment is implemented. This technique is adopted in ware house for material handling. The FLC based technique can be used either offline or online. The AGV in manufacturing environment is subjected to attractive force to the goal and repulsive force to the obstacle. The multi-valued fuzzy behavior system has been applied for the robot navigation to improve its performance. This method provides a reliable method of behavior fusion; this method ensures that no behavior is neglected during the process so that smooth navigation takes place in cluttered environment.

2.2 FLC BASED AUTONOMOUS ROBOT

Fuzzy logic approach for mobile robot navigation has been done using differential drive mechanism. The fuzzy logic-based approach for wall following robot uses the information obtained by the concept of general perception to guide the robot on the wall of arbitrary shape and obstacles (which is treated as part of wall). Complete membership function and fuzzy rule base has been provided for 2 successful navigation of robot. The ways to improve fuzzy logic controller based on different factors are considered for mobile robot navigation. The navigation has been improved either by modifying hardware (adding more sensors). The other method is purely by developing linguistic-based software. The system can be improved by using more time steps in the fuzzy inference process. The fuzzy logic controller receives input from sensors which determine the steering angle and velocity of vehicle for both local and global-based navigation. The minimum risk approach using fuzzy logic system has been used for autonomous robot navigation. This has achieved local path planning to escape from local minima and global-based robot navigation in unknown environment. This has proved to be successful through long wall, unstructured, cluttered maze like and modified environment. The approach adapts a strategy of multi-behavior coordination in which novel path searching behavior is developed to recommend the regional direction with minimum risk.

3. IMPLEMENTATION:

The block diagram of "Autonomous Robot Navigation" is designed with PIC18F452, GPS, GSM Module, Digital Compass, DC Motor, Ultrasonic sensor, LCD and LED.

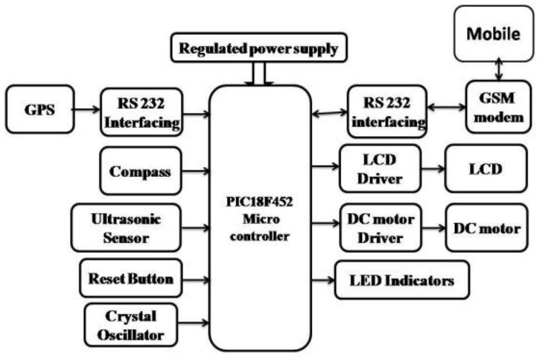

Fig-1: Block diagram of Autonomous robot Navigation

GPS and compass modules keep track of the current position and heading respectively, and help navigate vehicle towards the destination point. The destination point is entered by user and transmitted wirelessly to the vehicle via a GSM module. GPS was selected along with compass for navigation. Ultrasonic sensors have been widely used to detect and avoid obstacles in mobile robot and automobile applications. HC-SR04 ultrasonic sensors were chosen and installed on the front side of the vehicle because of their accuracy, speed, reliability and effectiveness in detecting distance from objects.

PIC Microcontroller:

In this project PIC18F452 Microcontroller board is used to control the whole unit of project. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

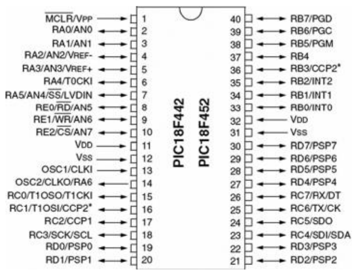

Fig-2: PIN diagram of PIC18F452

GPS:

GPS receiver is interfaced with microcontroller to give longitude and latitude values of robot. GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the robot exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received.

Digital Compass:

The Honeywell HMC5883L is a fully integrated compass module that combines 3-axis magneto-resistive sensors with the required analog and digital support circuits, and algorithms for heading computation. It was interfaced via I2C port with PIC18F452. Magnetometer is used for measurement of magnetic field direction in space. Most navigation systems use electronic compasses to determine heading direction.

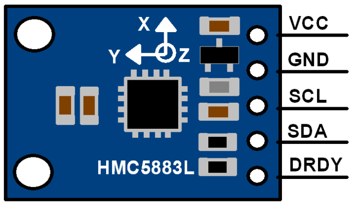

Fig-3: Magneto resistive sensor

Ultrasonic Sensor:

Ultrasonic sensors (also known as transceivers when they both send and receive, but more generally called transducers) work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

Fig-4: Ultrasonic sensor

DC Motor:

A motor is an electrical machine which converts electrical energy into mechanical energy.

The principle of working of DC motor is that whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force.

Fig-5: DC Motor

A 12 V DC motor was used for traction purpose while a 7.2 V digital servo motor having 40 kg/cm torque was utilized for heading navigation.

H Bridge driver

An H bridge circuit based on the L293D H Bridge IC is used to drive the traction motor. L293D IC can supply up to 4A current in pulse width modulation (PWM), dual mode, which is sufficient in this application.

GSM:

GSM, which stands for Global System for Mobile communications, reigns (important) as the world's most widely used cell phone technology. Cell phones use a cell phone service carrier's GSM network by searching for cell phone towers in the nearby area. Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication.

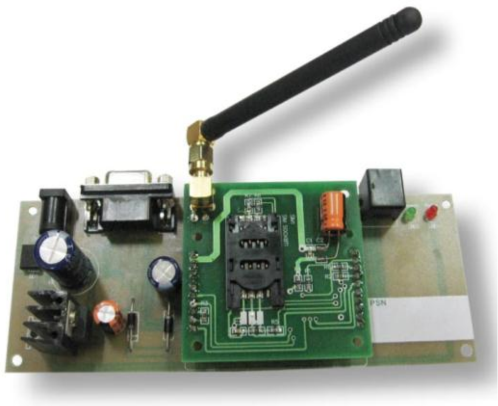

Fig-6: GSM Module

LCD Display:

One of the most common devices attached to a micro controller is an LCD display. Some of the most common LCD's connected to the many microcontrollers are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

In this project we are using 16x2 LCD Display, to display the location information of the robot.

4. FLOW CHART

The flow chart explains the behavior of project

4.1 Navigation Mode

- Initialization
- Boot up the GPS module and find the current coordinate.
- Set the course

Load designated waypoints into the list. Select the first waypoint and turn to the direction.

- Go to the waypoint
- Start traveling to the next waypoint. Once it gets to the waypoint, set the waypoint and the next waypoint as its new starting point and end point respectively.
- Repeat until it reaches the final destination.

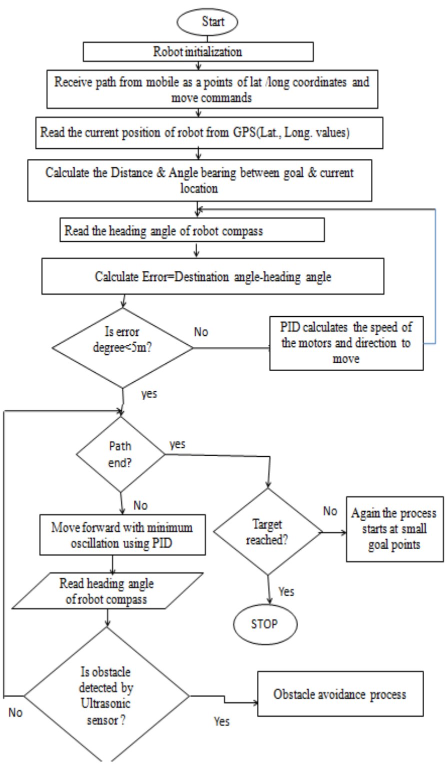

Fig-7: Navigation system

4.2 Obstacle Avoidance

- Obstacle detection
- Decide whether the object is in left or right.
- Correct actuator signal.

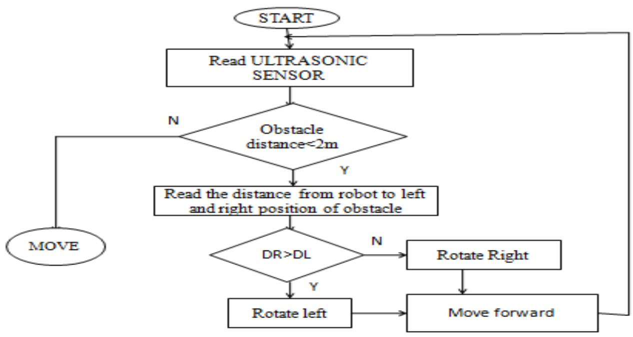

Fig-8: Obstacle avoidance process

4.3 Distance and Angle calculation

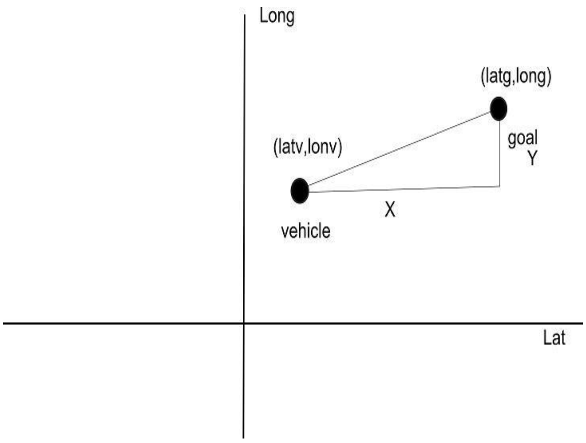

Fig-9: Distance and Angle calculation

$Y = \text{Long goal} - \text{long vehicle}$

$X = \text{Lat goal} - \text{lat vehicle}$

$\Theta_{goal} = \tan^{-1}(Y/X)$

$\text{Angle}(\Theta) = \text{Goal angle} - \text{Vehicle angle}$

Where,
X- Distance to be travelled in latitude
Y- Distance to be travelled in longitude
If the path between goal and vehicle is not straight line, small goal points are considered at the corners along the path.

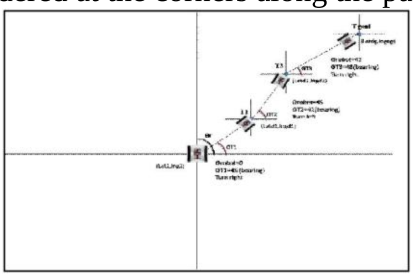

Fig-10: Robot choice direction at each points

5. RESULTS

In this we are successfully develop an autonomous robot that can move from one location to another with the help of GPS coordinates. The robot moves according the GPS coordinates it receives from the user in the form of SMS. The robot also detects the obstacles using ultrasonic sensor and alerts the user about its location through SMS message.

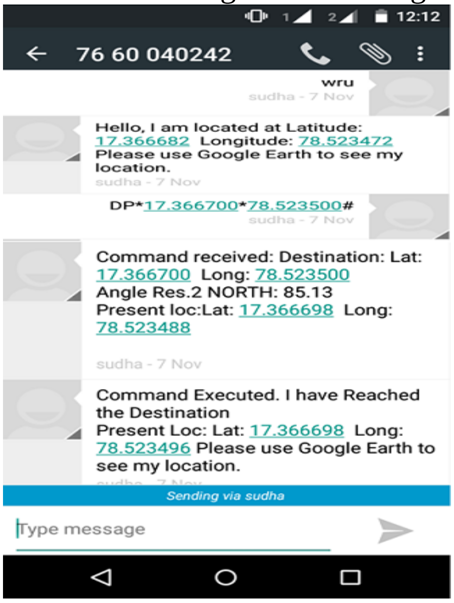

Fig-11: Communication between user and robot

The above image shows a real time screen capture of the SMS notification system in operation, the robot is programmed to send SMS notifications to the user through GSM Module. The user receives an SMS notification according to the direction of the robot.

The user sends the destination values (longitudinal and latitudinal) to the robot that will be displayed on LCD.

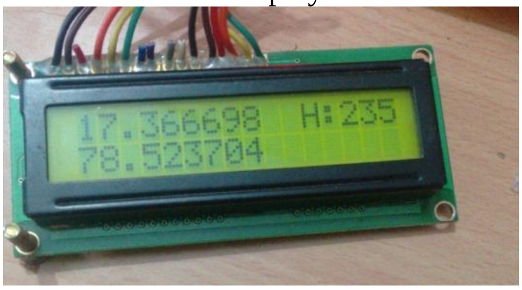

Fig-12: Destination location

If any obstacle detected the robot stops certain time and then move to another direction according to the values of compass.

Fig-13: Obstacle detection

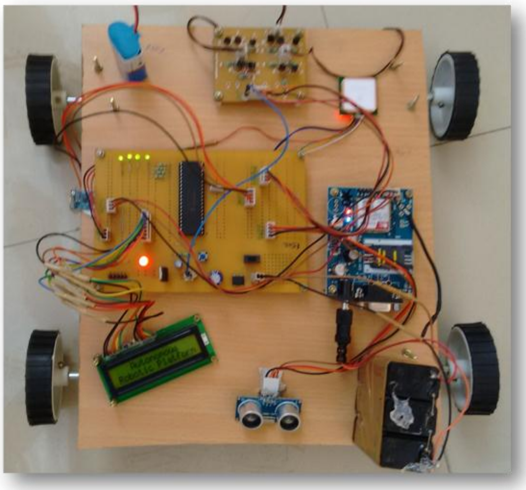

Fig-14: Robot Layout

6. CONCLUSION

This whole paper mainly focuses on developing an intelligent navigable robot using GPS, GSM and Digital compass. The robot moves according the GPS coordinates it receives from the user in the form of SMS. The robot also detects the obstacles using ultrasonic sensor and alerts the user about its location through SMS message.

7. ACKNOWLEDGEMENT

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